# RESEARCH APPLICATIONS PROGRAMS

Space Technology Center
The University of Kansas
Lawrence, Kansas 66045
(913) 864-4775

KARS

# Kansas Applied Remote Sensing Program



NASA National Aeronautics and Space Administration

THE SPACE TECHNOLOGY CENTER
KARS Kansas Applied Remote Sensing Program

# CROP PHENOLOGY AND LANDSAT-BASED IRRIGATED LANDS INVENTORY IN THE HIGH PLAINS

FIRST INTERIM REPORT
Grant No. NAG 2-57

(Period: September 1 - November 30, 1980)

Submitted to

National Aeronautics and Space Administration
Office of University Affairs
MS 241-25
Ames Research Center
Moffett Field, California 94035

E. A. Martinko
Principal Investigator

J. Poracsky
E. R. Kipp
H. Krieger


THE UNIVERSITY OF KANSAS CENTER FOR RESEARCH, INC.
2291 Irving Hill Drive—Campus West
Lawrence, Kansas 66045

NASA GRANT NO. NAG 2-57: FIRST INTERIM REPORT

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## ACCOMPLISHMENTS

The first period's activity concentrated on:

a) identifying crop and irrigation data sources for the eight states within the High Plains Aquifer and making contacts concerning the nature of these data;

b) researching bibliographic materials and acquiring relevant literature;

c) developing a mail questionnaire designed to gather specific data not routinely reported through standard data collection channels;

d) developing input/output routines for High Plains crop and irrigation data and inputting initial statistical data on crops to computer files.

### A. CONTACTS

The majority of the 71 contacts that were made consisted of persons within the state offices of the Economics and Statistics Service (ESS), Agricultural Stabilization and Conservation Service (ASCS), the Cooperative Extension Service and agencies involved in remote sensing within the study area (see Appendix I). This was done to (1) obtain names and addresses of county and crop reporting district agricultural agents, (2) identify the nature of data available from each agency, and (3) assess the present use of remote sensing within the study area.

During the period October 19-21, 1980, two staff members travelled to Lincoln, Nebraska to attend the Second National Irrigation Symposium. A large part of this meeting dealt specifically with the High Plains area and was well attended by persons involved in irrigation from all of the eight states in the High Plains region. The trip proved to be extremely valuable in identifying and contacting other persons working with irrigation within the study area (see Appendix II).

One member of the staff attended the first day of a two-day workshop in Kansas City, Missouri given by the EROS Data Center on October 26 and 27 and entitled "Agricultural Remote Sensing Workshop." Several persons were contacted concerning methods for using crop calendar data for choosing optimal Landsat dates for crop identification studies (see Appendix III).

B. LITERATURE REVIEW

Materials obtained include pas studies of the Ogallala Formation, general and specific information regarding cropping practices in the area and remote sensing research concerned with crop calendar development. Among the sources surveyed were the USDA Cooperative Extension publications and the U.S. Geological Survey publications of each state, in addition to several remote sensing bibliographies. A total of 264 relevant publications were located.

C. QUESTIONNAIRE DEVELOPMENT

Based on agency and symposium contacts and a review of the literature, a mail questionnaire was developed for gathering data concerning cropping and irrigation practices at the county level. Several drafts have been made; the most recent draft can be found in Appendix IV.

The specific goal of the questionnaire is to gather detailed spatial data of a finer resolution than is routinely available from county-wide statistics concerning:

1) non-major crops (those not reported in standard agricultural statistical summaries), especially those crops which could cause confusion with the major crops;
2) irrigation spatial patterns, particularly the intensity of irrigation and degree of usage with specific crops;
3) specific dates of important phenological changes and potential local variations from the general pattern.

D. DATA PROCESSING

A data file structure was identified that would allow crop and irrigation data for the study area to be easily stored and manipulated by computer. Input and output routines were written to allow convenient modification of data and to permit retrieval in desired tabular format (see Appendix V). These data will be utilized during the later periods of this study in order to identify the phenological patterns and to prepare various maps of the region with the assistance of the computer.

E. ADDITIONAL REQUESTS FROM THE FUNDING AGENCY

During the month of November, because of priority deadlines that NASA and USGS are required to meet, the KARS Program was requested to provide a preliminary analysis of the crop calendars of the High Plains region for 1980 using the weekly Crop and Livestock Summary reports of the USDA's Department of Economics and Statistics Service. This effected some rescheduling of other work proposed by the KARS Program. A summary of the steps to be used in this preliminary analysis can be found in Appendix VI.

FINDINGS

The Kansas Crop and Livestock Report Service (USDA/ESS) provided the following information regarding their data collection techniques:

1) The Kansas ESS regularly collects three different sets of data. With minor variations these data collection efforts are standardized throughout the entire High Plains area.
   a) During the growing season data are collected monthly from a sample of about 3000 farmers (crop reporters). Any one month apparently yields data from about 1400 reporters. Each reporter tells either about the crops on his farm only or about general trends and conditions on farms in his area, including both his and neighbors' farms.

b) At the end of the growing season an acreage and production survey is performed. About 5000 farmers are contacted and asked about general farm conditions and yields. This information is used to make county-based estimates.

c) Objective yield measurements are made on a random sample of fields for corn, soybeans and wheat (the crops of course differ from state to state). In addition, sorghum data will be collected on an experimental basis in Kansas beginning next year. Data are collected for a small area (about 1 square yard for wheat, a specific length of rows for corn) chosen within each sample field and detailed measurements made of yield.

2) The specific sample data are not available, only the county and Crop Reporting District projections based on the sample. These are all published and readily available.

3) Weekly progress reports on crops and growing conditions are provided to the ESS by the Extension agents in each of the counties. These are the contents of the published weekly reports.

4) It was estimated that the ASCS agents would probably be more knowledgable (though not necessarily more reliable; this would be a function of length of experience in that county) about irrigation than would the Extension Agents.

The following information was obtained concerning data collection by ASCS.

1) Black and white photography is flown every 4 to 5 years.

2) 35mm natural color photography is flown once or twice yearly; this flight frequency varies with the individual needs of the county ASCS offices.

3) No quantitative data are available concerning any kind of total county crop figures, although ASCS agents are familiar enough with the crop phenomenon that they are aware of the qualitative aspects of such data.

## PROBLEMS

The survey questionnaire was tested by both a county agent with the Cooperative Extension Service and one with ASCS. Each agent warned us that, although they could see the need for such information, the percent of agents that would return the document would likely be extremely low. Presently we are in the process of reassessing this method of gathering these data.

## PROJECTED WORK FOR THE SECOND PERIOD

Work for the next period will consist of detailed data collection and analysis, specifically:

1) preliminary identification of optimal Landsat image dates for 1980 based on the ESS weekly Crop and Livestock Reports from each state within the study area (to be completed January 5, 1980);
2) completion of agricultural statistics input to the computer (to be completed February 1, 1980); and
3) initial analysis of crop and irrigation statistics correlated with phenological data (to be completed January 15, 1980).

# APPENDIX I

# LIST OF CONTACTS

CONTACTS IDENTIFIED AS SOURCES OF CROP AND IRRIGATION DATA WITHIN THE STUDY AREA

| | SOURCE OF WHERE TO GET INFORMATION | STATE AGRICULTURAL STATISTICS | CROP REPORTING DISTRICT STATISTICS | COUNTY AGRICULTURAL STATISTICS | IRRIGATION BY STATE | IRRIGATION BY CROP REPORTING DISTRICT | DATA TYPE: IRRIGATION BY COUNTY | DATA TYPE: IRRIGATION BY CROP | DATA TYPE: IRRIGATION LOCATION | SUPPLIES FIGURES FOR "IRRIGATION JOURNAL" | PHENOLOGICAL DATA | REMOTE SENSING INFORMATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COLORADO | | | | | | | | | | | | |
| Bud Bishop, ASCS State Office, Denver | | X | | X | | | X | X | X | | X | |
| Curtis Lund, ESS State Office, Denver | | X | X | X | X | | | | | | | |
| Lowell Watts, Cooperative Extension Service, Fort Collins | X | | | | | | | | | | | |
| Don Miles, Irrigation Engineer, Rocky Ford | | | | | X | | X | X | X | X | | |
| Robert Evans, Extension Irrigation Engineer, Fort Collins | X | | | | | | | | | | | |
| Gene Maxwell, Colorado State University, College of Natural Science, Fort Collins | | | | | | | | | | | X | |
| James Echols, Extension Agronomist, Fort Collins | | | | | | | | | | X | | |
| Jerry Danielson, State Engineer's Office, Denver | | | | | | | | X | | | | |
| KANSAS | | | | | | | | | | | | |
| ASCS State Office, Manhattan | | X | | X | | | | | | | | |
| Mo Johnson, ESS Office, Topeka | | X | X | X | | | | | | | | |
| John Dunbar, Cooperative Extension Service, Manhattan | X | | | | | | | | | | | |
| Earl Van Meter, Cooperative Extension Service, Laurence | X | | | | | | | | | | | |
| DeLynn Hay, Extension Irrigation Engineer, Manhattan | | | | | X | | X | X | X | | | |
| NEBRASKA | | | | | | | | | | | | |
| ASCS State Office, Lincoln | X | | | X | | | | | | | | |
| Bill Day, ESS State Office, Lincoln | | X | X | | | | | | | | | |
| Micky Stewart, ESS State Office, Lincoln | | | | | X | | | | | | | |
| Leo Lucas, Cooperative Extension Service, Lincoln | X | | | | | | | | | | | |
| (continued) | | | | | | | | | | | | |

CONTACTS IDENTIFIED AS SOURCES OF CROP AND IRRIGATION DATA WITHIN THE STUDY AREA

| | SOURCE OF WHERE TO GET INFORMATION | DATA TYPE: STATE AGRICULTURAL STATISTICS | CROP REPORTING DISTRICT STATISTICS | COUNTY AGRICULTURAL STATISTICS | IRRIGATION BY STATE | IRRIGATION BY CROP REPORTING DISTRICT | IRRIGATION BY COUNTY | IRRIGATION BY CROP | IRRIGATION LOCATION | SUPPLIES FIGURES FOR "IRRIGATION JOURNAL" | PHENOLOGICAL DATA | REMOTE SENSING INFORMATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEBRASKA (contd.) | | | | | | | | | | | | |
| August Dryer, Extension Agronomist, Lincoln | X | | | | | | | | | | X | |
| Paul Seevers, Univ. of Nebraska, Remote Sensing Div., Lincoln | | | | | | | | | X | | | |
| Paul Fischbach, Extension Irrigation Engineer, Lincoln | X | | | | | | | | | X | | |
| John Newberger, Dept. of Water Resources, Lincoln | | | | | | | | | X | | | |
| NEW MEXICO | | | | | | | | | | | | |
| Lucia Tafoya, ASCS State Office, Albuquerque | | | | X | | | | | | | | |
| ESCS State Office, Las Cruces | | X | X | | | | | | | | | |
| L. S. Pope, Cooperative Extension Service, Las Cruces | X | | | | | | | | | | | |
| Charles Grover, Extension Agronomist, Las Cruces | | | | | | | | | | | X | |
| Dr. Niehaus, Extension Agronomist, Las Cruces | | | | | | | | X | X | | | |
| Robert Hulsman, Extension Irrigation Engineer, Las Cruces | X | | | | | | | | | | | |
| Charles Huhn, Extension Engineer, Las Cruces | | | | | | | | | | X | | |
| OKLAHOMA | | | | | | | | | | | | |
| ASCS State Office, Stillwater | | | | X | | | | | | | | |
| John Ranek, Ag. Statistician, ESCS State Office, Oklahoma City | | X | X | | | | | | | | | |
| C. D. Browning, Cooperative Extension Service, Stillwater | X | | | | | | | | | | | |
| Dr. Paul Santelmann, Extension Agronomist, Stillwater | | | | | | | | | | | X | |
| Delbert Schwab, Extension Irrigation Engineer, Stillwater | | | | | X | | X | X | X | | | |
| Oklahoma Water Resources Board, Oklahoma City | | | | | | | | | X | | | |
| Steve Walsh, Center for Applied Remote Sensing, Stillwater | | | | | | | | | | | | X |

(continued)

CONTACTS IDENTIFIED AS SOURCES OF CROP AND IRRIGATION DATA WITHIN THE STUDY AREA

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOUTH DAKOTA | | | | | | | | | | | | |
| ASCS State Office, Huron | | | | | | | X | | | | | |
| ESCS State Office, Sioux Falls | | X | X | | | | | | | | | |
| Hollis Hall, Cooperative Extension Service, Brookings | X | | | | | | | | | | | |
| Fred Weston, Plant Science Dept., S. Dakota State Univ., Brookings | | | | | | | | | | | X | X |
| Victor Myers, Remote Sensing Institute, S. Dakota State Univ., Brookings | | | | | | | | | | | | X |
| Paul Weeldreyer, Extension Irrigation Engineer, Pierre | X | | | | | | | X | X | | | |
| W. H. Anderson, EROS Data Center, Sioux Falls | X | | | | | | | | | | | X |
| Division of Water Rights, Pierre | | | | | | | | | X | | | |
| John Wiersma, Water Resources Institute, Brookings | | | | | | | | | X | | | |
| TEXAS | | | | | | | | | | | | |
| Ralph McKinney, ASCS State Office, College Station | | | | X | | | | | | | | |
| ESCS State Office, Austin | | X | X | | | | | | | | | |
| Dan Pfannstiel, Cooperative Extension Service, College Station | X | | | | | | | | | | | |
| Wayne Keese, Extension Irrigation Engineer, College Station | X | | | | | | | | X | | | |
| Leon New, Extension Irrigation Engineer, Lubbock | X | | | | | | | | X | | | |
| Leland Tripp, Extension Agronomist, College Station | X | | | | | | | | | | X | |
| Bruce Blanchard, Remote Sensing, Texas A&M Univ., College Statin | | | | | | | | | | | X | |
| Texas Department of Water Resources, Austin | | | | | | | | | X | | | |

(continued)

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OF CROP AND IRRIGATION DATA
WITHIN THE STUDY AREA

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WYOMING | | | | | | | | | | | | |
| Carl Otto, ASCS State Office, Casper | | | | X | | | | | | | | |
| L. Odell Larson, ESCS State Office, Cheyenne | | X | X | | | | | | | | | |
| Harold Tuma, Cooperative Extension, Laramie | X | | | | | | | | | | | |
| Dr. Becker, Extension Agricultural Meteorologist, Laramie | X | | | | | | | | | | | |
| Dr. Painter, Extension Agronomist, Laramie | X | | | | | | | X | X | | X | |
| Don Brose, Extension Irrigation Engineer, Laramie | | | | | | | | X | X | | | |
| George Christopolis, State Engineer's Office, Cheyenne | | | | | | | | | X | | | |
| OTHERS | | | | | | | | | | | | |
| ASCS National Data Center | X | | | | | | | | | | | |
| 1. Fred Plybon, Data Operations Division | X | | | | | | | | | | | |
| 2. Herbert Case, Commodity Credit Office | X | | | | | | | | | | | |

# APPENDIX II:

## SECOND NATIONAL IRRIGATION SYMPOSIUM
## PROGRAM AND LIST OF CONTACTS

IRRIGATION
Challenges in the 80's

# Second National Irrigation Symposium

**October 20-23, 1980**
**Nebraska Center**
**for Continuing Education**
**Lincoln, Nebraska**

SPONSORED
BY


American Society of
Agricultural Engineers

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St. Joseph, Michigan

**Cooperating Organizations**

American Society of Agronomy
American Society of Civil Engineers
Irrigation Association
Soil Conservation Society of America
Soil Science Society of America
U.S. Committee of the International Commission on Irrigation, Drainage and Flood Control
USDA—Science and Education Administration

## Symposium Committees

**General Planning Committee**

D. D. Fangmeier, Co-Chairman
University of Arizona

D. F. Heermann, Co-Chairman
USDA-SEA-AR

P. E. Fischbach
University of Nebraska

G. J. Hoffman
U.S. Salinity Laboratory

M. E. Jensen
USDA-SEA-AR

M. A. Purschwitz
ASAE

L. Reid
Nebraska Center for Continuing Education

G. V. Skogerboe
Colorado State University

**Program Committee**

D. F. Heermann, Chairman
USDA-SEA-AR

J. W. Addink
Addink Engineering

C. L. Anderson
University of Missouri

J. R. Gilley
University of Nebraska

T. A. Howell
USDA-SEA-AR

E. G. Kruse
USDA-SEA-AR

H. L. Manges
Kansas State University

J. A. Replogle
U.S. Water Conservation Laboratory

K. H. Solomon
Rain Bird, Inc.

E. C. Stegman
North Dakota State University

G. L. Westesen
Montana State University

**Publications Committee**

G. J. Hoffman, Chairman
U.S. Salinity Laboratory

H. R. Duke
USDA-SEA-AR

**Publicity Committee**

G. V. Skogerboe, Chairman
Colorado State University

J. A. Lee
Jim Lee Sales

A. J. Miller
A. J. Miller, Inc.

T. J. Schlitz
Irrigation Association

**Finance Committee**

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University of Arizona

M. A. Purschwitz
ASAE

L. Reid
Nebraska Center for Continuing Education

**Local Arrangements**

P. E. Fischbach, Chairman
University of Nebraska

D. D. Fangmeier
University of Arizona

L. Reid
Nebraska Center for Continuing Education

**Exhibits Committee**

A. R. Dedrick, Chairman
U.S. Water Conservation Laboratory

# Second National Irrigation Symposium

## Monday, October 20, 1980

### IRRIGATION DEVELOPMENT

Presiding: *D. F. Heermann*, Agr. Engr., USDA-SEA-AR, Ft. Collins, CO; Secretary, Soil & Water Division, ASAE

**9:00 Welcome—**

MARTIN MASSENGALE, Vice-Chancellor, Institute of Agriculture and Natural Resources, University of Nebraska

**Welcome—**

W. E. SPLINTER, Head, Agr. Eng. Dept., Univ. of Nebraska, Lincoln; Past President, ASAE

**9:30 Irrigation Development in California—Construction or Water Management**

*Ron Robie*, Director, Dept. of Water Resources, State of California

**10:15 Break**

**10:45 Irrigation Development in Nebraska and Great Plains**

*R. A. Luetzke*, Lt. Governor, State of Nebraska

**11:30 Current Status of Irrigation in the United States**

*D. J. Bross*, Ext. Irrigation Engr., University of Wyoming, Laramie

**12:00 Lunch**

### IMPACTS OF IRRIGATION DEVELOPMENT

Presiding: *D. D. Fangmeier*, Prof., Univ. of Arizona, Tucson; Past Chairman, Soil & Water Division, ASAE

**1:30 On the Economic Return to Irrigation**

*Robert Young*, Professor of Economics, Colorado State University, Fort Collins

**2:00 Public Image of Irrigation**

*Hester McNulty*, Natural Resources Coordinator, League of Women Voters of the United States, Boulder, CO

**2:30 Benefits of Irrigation to Consumer**

*William Wood*, Extension Economist, University of California, Riverside

**3:00 Break**

**3:30 Environmental Concerns of Irrigation**

*Zack Willey*, Environmental Defense Fund, Inc., California

**4:00 Summary—Discussion—Challenges**

*M. E. Jensen*, Director, Soil and Water Division, ASAE

## Tuesday, October 21, 1980

### ADVANCES IN IRRIGATION SYSTEMS

Presiding: *C. L. Anderson*, Irr. Consultant, Columbia, MO; Chairman, Irrigation Group, ASAE

**8:30 Advances in Operation, Maintenance and Rehabilitation of Irrigation Delivery Systems**

*W. J. Bardin*, Consult. Engr., J. M. Montgomery Co., Walnut, CA; *G. V. Skogerboe*, Prof., Colo. State Univ., Fort Collins; *W. R. Walker*, Sevier River Comm., Delta, Utah; *D. Wesner*, Salt River Project, Phoenix, AZ

**9:00 Advances in Sprinkler Irrigation**

*J. W. Addink*, Addink Assocs., Lincoln, NE; *R. E. Sneed*, North Carolina State Univ., Raleigh; *M. H. J. Miller*, Marion Miller & Assocs., Colorado Springs, CO; *C. H. Pair*, Consult. Engr., Boise, ID

**10:00 Break**

**10:30 Advances in Surface Irrigation**

*E. G. Kruse*, Agr. Engr., USDA-SEA-AR, Fort Collins, CO; *D. D. Fangmeier*, Prof., Univ. of Arizona, Tucson; *A. S. Humphreys*, Agr. Engr., USDA-SEA-AR, Kimberly, ID; *H. L. Manges*, Prof., Kansas State Univ., Manhattan, KS

**11:45 Discussion**

**12:00 Lunch**

### ADVANCES IN IRRIGATION SYSTEMS

Presiding: *H. L. Manges*, Prof., Kansas State Univ., Manhattan; Chairman, Surface Irrigation Committee, ASAE

**1:30 Advances in Trickle Irrigation**

*T. A. Howell*, Agr. Engr., USDA-SEA-AR, Fresno, CA; *D. A. Bucks*, Agr. Engr., USDA-SEA-AR, Phoenix, AZ; *J. L. Chesness*, Prof., Univ. of Georgia, Athens

**2:30 Evaluation of Irrigation Systems**

*J. Keller*, Prof., Utah State Univ., Logan; *M. E. Vavra*, Engr., SCS, Austin, TX; *F. Corey*, Corey Assocs., Tempe, AZ; *A. D. Halderman*, Prof., Univ. of Arizona, Tucson

**3:15 Break**

**3:45 Selection of Irrigation Method**

*J. M. Lord*, Lord Assocs., Fresno, CA; *C. M. Burt*, Consult. Irr. Engr., San Luis Obispo, CA; *G. T. Thompson*, Prof., Washington State Univ., Prosser

LIST OF CONTACTS FROM THE SECOND INTERNATIONAL IRRIGATION SYMPOSIUM

| | SOURCE OF WHERE TO GET INFORMATION | DATA TYPE: STATE AGRICULTURAL STATISTICS | CROP REPORTING DISTRICT STATISTICS | COUNTY AGRICULTURAL STATISTICS | IRRIGATION BY STATE | IRRIGATION BY CROP REPORTING DISTRICT | IRRIGATION BY COUNTY | IRRIGATION BY CROP | IRRIGATION LOCATION | SUPPLIES FIGURES FOR "IRRIGATION JOURNAL" | PHENOLOGICAL DATA | REMOTE SENSING INFORMATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jerry Walker, Soil Conservation Service, Amarillo, TX | X | | | | | | X | X | X | | | |
| Glenn Vittietoe, State Soil Conservation Service Office, Temple, TX | | | | | X | | X | | X | | | |
| North Plains Underground Water District, Dumas, TX | | | | | | | | | X | | | |
| High Plains Underground Water District, Lubbock, TX | | | | | | | | | X | | | |
| Panhandle Groundwater Conservation District, Whitedeer, TX | | | | | | | | | X | | | |
| Leon New, Extension Irrigation Engineer, Lubbock, TX | | | | | | | | | X | | | |
| Bruce Blanchard, Texas A&M University, College Station, TX | | | | | | | | | | | | X |
| Ted Sammis, Extension Irrigation Engineer, Las Cruces, NM | | | | | | | | | X | | | |
| Daryl Paul, Extension Irrigation Engineer, Brookings, SD | | | | | | | | | X | | | |
| Charles Ullery, Water Resources Specialist, Brookings, SD | | | | | | | | | X | | | |

# APPENDIX III

## EROS DATA CENTER WORKSHOP
## "REMOTE SENSING IN AGRICULTURE"
## SYLLABUS

# Workshop

## Remote Sensing in Agriculture

**OCTOBER 26-27, 1980**
**KANSAS CITY**

**Sponsored by**

**U.S. Department of the Interior**

**Geological Survey**

EARTH RESOURCES OBSERVATION SYSTEMS
EROS DATA CENTER
SIOUX FALLS, S.D. 57198

# Workshop

## Remote Sensing in Agriculture

October 26-27, 1980
Kansas City, Missouri

| Sunday, October 26 | Topic | Instructor |
|---|---|---|
| 7:00- 8:00 a.m. | Registration | Staff |
| 8:00- 8:30 a.m. | Welcome and Introduction<br>Review of Schedule<br>Workshop Objectives | W.H. Anderson |
| 8:30-10:15 a.m. | Overview of Remote Sensing<br>The Electromagnetic Spectrum<br>Characteristics of Aerial Photographs<br>Basic Principles of Interpretation<br>Class Exercises in Photo Measurement and Stereo Viewing | G.E. Johnson |
| 10:15-10:30 a.m. | Break | |
| 10:30-11:00 a.m. | The Landsat System | T.R. Loveland |
| 11:00-Noon | Crop Reflectance Characteristics<br>Principles of Vegetation Interpretation<br>Color Infrared Film | P.M. Seevers |
| Noon- 1:00 p.m. | Lunch | |
| 1:00- 2:30 p.m. | Survey of Crop Identification Techniques<br>Vegetation Stress Detection<br>The Time Dimension and Phenology | W.H. Anderson |
| 2:30- 2:45 p.m. | Break | |
| 2:45- 3:45 p.m. | Overview of Computer-Assisted Analysis Techniques<br>Geo-Based Information Systems | T.R. Loveland |
| 3:45- 5:30 p.m. | Case Studies in Agricultural Remote Sensing | Staff |
| 5:30 p.m. | Adjourn | |

| Monday, October 27 | Topic | Instructor |
|---|---|---|
| 8:00-10:30 a.m. | Class Exercises in Image Interpretation | W.H. Anderson |
| 10:30-12:30 p.m. | Field Trip | |
| 12:30- 1:30 p.m. | Lunch in Field<br>Return to Classroom | |
| 1:30- 2:30 p.m. | Acquiring and Using 35mm Aerial Photographs | P.M. Seevers |
| 2:30- 3:00 p.m. | Sources of Imagery and Assistance | G.E. Johnson |
| 3:00- 4:00 p.m. | Question and Answer Period<br>Concluding Remarks and Summary<br>Workshop Critique | Staff |
| 4:00 p.m. | Adjourn | |

# APPENDIX IV

## DRAFT OF QUESTIONNAIRE

Dear

The University of Kansas Applied Remote Sensing (KARS) Program has undertaken a research project with the National Aeronautics and Space Administration and the U.S. Geological Survey to investigate crop calendars for 1979 and 1980. This information will be used to assist in developing techniques for mapping irrigated lands in the High Plains Aquifer region.

In the course of this study, we will be surveying and compiling data on the agricultural activities of your state. Enclosed you will find a copy of a survey questionnaire that we plan on using to gather these data. The questionnaire should take about 30 minutes to finish.

We wish to survey the county extension agents in your state and we would like to ask for your support in this endeavor. Could you please provide us with a list of names, addresses and phone numbers for both the extension agronomist and the extension irrigation engineer for the counties listed on the accompanying sheet?

Your cooperation in this research effort is greatly appreciated. It is our hope that you will be able to supply the above list since, ultimately, our research will benefit your state. If you would like a copy of the survey results, please fill in your address on the enclosed mailing label and return it to the KARS Program.

Any comments or questions you may have would be welcome. Do not hesitate to contact either of us.

Sincerely,

Joe Poracsky
Senior Remote Sensing
Applications Specialist

Liz Kipp
Graduate Research Assistant

LK:ak

Enclosures

Dear Sir/Madam:

The University of Kansas Applied Remote Sensing (KARS) Program is engaged in a research project to compile crop calendars for 1979 and 1980 and to investigate the extent of irrigated lands within the High Plains region. Your knowledge and experience can help us to determine much of the required information for your area. This information will be used in research designed to gather data for assessing groundwater depletion in the High Plains region.

Enclosed is a questionnaire concerning several aspects of agriculture and irrigation. We would greatly appreciate your assistance in filling in the questionnaire to the best of your knowledge for your county. In the case of questions for which you do not systematically collect data please try to be as accurate as possible. After completing the questionnaire, please return it to the KARS Program in the enclosed envelope. If at all possible, please return it by December 17. It should take only 30 minutes to complete the entire form since not all blanks will apply to your county.

Your cooperation in completing this questionnaire at your earliest convenience is appreciated. If you would like a copy of the survey results, please fill in your address on the enclosed mailing label and return it with the questionnaire.

If you have any questions, please do not hesitate to contact either of us.

Sincerely,

Joe Poracsky
Senior Remote Sensing
Applications Specialist

Liz Kipp
Graduate Research Assistant

LK:ak

Enclosures

DATE: _____ PHONE: _____

NAME: _____ # YEARS LIVED IN COUNTY: _____

TITLE: _____

EMPLOYER: _____

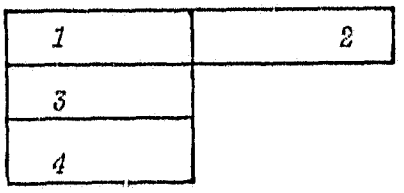
BUSINESS ADDRESS: _____
Street

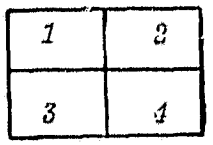
_____
County

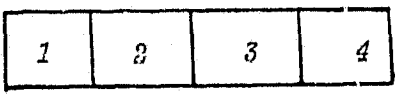
_____
State

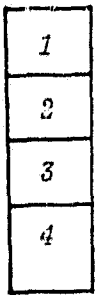
Several of the following questions refer to areas within your county. We ask that you sketch an outline of your county and divide it into four quadrants approximately equal in area and number each quadrant #1, #2, #3 and #4. In the questions that follow, please use these designated numbers to the corresponding #1, #2, #3 and #4 that are given in the question.

*EXAMPLE SKETCHES OF A COUNTY*




SKETCH OF YOUR COUNTY

1. [illegible] 19[illegible]. Please indicate the total number of acres each crop, per tag the total acreage grown in each quadrant of the county, the acreage under irrigation and the number of acres under each method of irrigation. Please be as accurate as possible. The first entry (sugar cane) is an example.

| CROP | TOTAL ACREAGE | % OF CROP IN EACH QUADRANT | | | | IRRIGATED ACREAGE | IRRIGATION METHOD - no. of acres | | |
|---|---|---|---|---|---|---|---|---|---|
| | | #1 | #2 | #3 | #4 | | FLOOD | CENTER PIVOT | OTHER SPRINKLER |
| *SUGAR CANE* | *65,800* | *10* | *25* | *65* | *0* | *36,500* | *21,500* | *10,600* | *4,400* |
| ALFALFA | | | | | | | | | |
| BARLEY, spring | | | | | | | | | |
| BARLEY, winter | | | | | | | | | |
| CORN, grain | | | | | | | | | |
| CORN, silage | | | | | | | | | |
| COTTON | | | | | | | | | |
| FIELD BEANS | | | | | | | | | |
| HAY (except alfalfa) | | | | | | | | | |
| OATS | | | | | | | | | |
| PEANUTS | | | | | | | | | |
| PECANS | | | | | | | | | |
| POTATOES | | | | | | | | | |
| RYE | | | | | | | | | |
| SORGHUM, forage | | | | | | | | | |
| SORGHUM, grain | | | | | | | | | |
| SOYBEANS | | | | | | | | | |
| SUGAR BEETS | | | | | | | | | |
| SUNFLOWERS | | | | | | | | | |
| WHEAT, spring | | | | | | | | | |
| WHEAT, winter | | | | | | | | | |
| OTHER: | | | | | | | | | |
| OTHER: | | | | | | | | | |
| OTHER: | | | | | | | | | |
| OTHER: | | | | | | | | | |

2. For 1979 Please indicate the total number of acres in each crop, the percentage of that total acreage grown in each quadrant of the county, the acreage under irrigation and the number of acres under each method of irrigation. Please be as accurate as possible. The first entry (sugar cane) is an example.

| CROP | TOTAL ACREAGE | % OF CROP IN EACH QUADRANT | | | | IRRIGATED ACREAGE | IRRIGATION METHOD - no. of acres | | |
|---|---|---|---|---|---|---|---|---|---|
| | | #1 | #2 | #3 | #4 | | FLOOD | CENTER PIVOT | OTHER SPRINKLER |
| *SUGAR CANE* | *65,800* | *10* | *25* | *65* | *0* | *36,500* | *21,500* | *10,000* | *5,000* |
| ALFALFA | | | | | | | | | |
| BARLEY, spring | | | | | | | | | |
| BARLEY, winter | | | | | | | | | |
| CORN, grain | | | | | | | | | |
| CORN, silage | | | | | | | | | |
| COTTON | | | | | | | | | |
| FIELD BEANS | | | | | | | | | |
| HAY (except alfalfa) | | | | | | | | | |
| OATS | | | | | | | | | |
| PEANUTS | | | | | | | | | |
| PECANS | | | | | | | | | |
| POTATOES | | | | | | | | | |
| RYE | | | | | | | | | |
| SORGHUM, forage | | | | | | | | | |
| SORGHUM, grain | | | | | | | | | |
| SOYBEANS | | | | | | | | | |
| SUGAR BEETS | | | | | | | | | |
| SUNFLOWERS | | | | | | | | | |
| WHEAT, spring | | | | | | | | | |
| WHEAT, winter | | | | | | | | | |
| OTHER: | | | | | | | | | |
| OTHER: | | | | | | | | | |
| OTHER: | | | | | | | | | |
| OTHER: | | | | | | | | | |

3. Please fill in the following table with the appropriate planting and harvesting dates for 1980 and 1979. Be as close to the day in your estimate as possible. The first entry (sugar cane) is an example.

| CROP | 2% PLANTED | | 50% PLANTED | | 95% PLANTED | | 2% HARVESTED | | 50% HARVESTED | | 95% HARVESTED | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1980 | 1979 | 1980 | 1979 | 1980 | 1979 | 1980 | 1979 | 1980 | 1979 | 1980 | 1979 |
| *SUGAR CANE* | *Apr 3* | *Apr 8* | *Apr 10* | *Apr 16* | *Apr 18* | *Apr 23* | *Oct 3* | *Oct 4* | *Oct 11* | *Oct 10* | *Oct 17* | *Oct 18* |
| BARLEY, spring | | | | | | | | | | | | |
| BARLEY, winter | | | | | | | | | | | | |
| CORN, grain | | | | | | | | | | | | |
| CORN, silage | | | | | | | | | | | | |
| COTTON | | | | | | | | | | | | |
| FIELD BEANS | | | | | | | | | | | | |
| FLAX | | | | | | | | | | | | |
| OATS | | | | | | | | | | | | |
| PEANUTS | | | | | | | | | | | | |
| PECANS | | | | | | | | | | | | |
| POTATOES | | | | | | | | | | | | |
| RYE | | | | | | | | | | | | |
| SORGHUM, forage | | | | | | | | | | | | |
| SORGHUM, grain | | | | | | | | | | | | |
| SOYBEANS | | | | | | | | | | | | |
| SUGAR BEETS | | | | | | | | | | | | |
| SUNFLOWERS | | | | | | | | | | | | |
| WHEAT, spring | | | | | | | | | | | | |
| WHEAT, winter | | | | | | | | | | | | |
| OTHER: | | | | | | | | | | | | |
| OTHER: | | | | | | | | | | | | |
| OTHER: | | | | | | | | | | | | |
| OTHER: | | | | | | | | | | | | |

4. If alfalfa and/or other hay is grown in your county, please indicate the approximate date (e.g., May 30) that each cutting took place.

| CROP | 1st CUTTING 2% COMPLETE | 1st CUTTING 50% COMPLETE | 1st CUTTING 95% COMPLETE | 2nd CUTTING 2% COMPLETE | 2nd CUTTING 50% COMPLETE | 2nd CUTTING 95% COMPLETE | 3rd CUTTING 2% COMPLETE | 3rd CUTTING 50% COMPLETE | 3rd CUTTING 95% COMPLETE |
|---|---|---|---|---|---|---|---|---|---|
| DRYLAND ALFALFA | | | | | | | | | |
| IRRIGATED ALFALFA | | | | | | | | | |
| DRYLAND OTHER HAY | | | | | | | | | |
| IRRIGATED OTHER HAY | | | | | | | | | |

| CROP | 4th CUTTING 2% COMPLETE | 4th CUTTING 50% COMPLETE | 4th CUTTING 95% COMPLETE | 5th CUTTING 2% COMPLETE | 5th CUTTING 50% COMPLETE | 5th CUTTING 95% COMPLETE |
|---|---|---|---|---|---|---|
| DRYLAND ALFALFA | | | | | | |
| IRRIGATED ALFALFA | | | | | | |
| DRYLAND OTHER HAY | | | | | | |
| IRRIGATED OTHER HAY | | | | | | |

5. For each quadrant of the county, indicate the percentage of all cropland that was under irrigation in 1980 and 1979.

| LOCATION | 1980 | 1979 |
|---|---|---|
| #1 | | |
| #2 | | |
| #3 | | |
| #4 | | |

6. Were individual fields used for a sequence of crops (multiple cropped) during the 1980 growing season? If so, what were the major sequences, beginning in spring and ending in winter?

| SEQUENCE | SPRING | SUMMER | FALL | WINTER |
|---|---|---|---|---|
| *Example* | *wheat* | *sorghum* | *fallow* | *fallow* |
| A. | | | | |
| B. | | | | |
| C. | | | | |
| D. | | | | |

7. On what percent of the total cropped land did each sequence outlined in question #1 occur in 1980?

| SEQUENCE | % |
|---|---|
| A. | |
| B. | |
| C. | |
| D. | |

8. Did the crop sequences listed in question #6 differ in 1979? If so, what were the sequences in 1979?

| SEQUENCE | % |
|---|---|
| A. | |
| B. | |
| C. | |
| D. | |

9. On what percent of the total cropped land did each multiple cropping practice occur in 1979?

| SEQUENCE | % |
|---|---|
| A. | |
| B. | |
| C. | |
| D. | |

10. Are minimum tillage practices used in your county? If so, please indicate for each quadrant of the county the percentage of total cropland that was under minimum tillage in 1980 and 1979.

| LOCATION | 1980 | 1979 |
|---|---|---|
| #1 | | |
| #2 | | |
| #3 | | |
| #4 | | |

11. The following table concerns the sources of your information. Please check the column which corresponds to the method by which data are recc ded and the source of each type of data.

| DATA TYPE | THIS INFORMATION IS: RECORDED ON PAPER IN THE FIELD | RECORDED IN THE OFFICE AFTER FIELD TRIP | NOT RECORDED | THIS INFORMATION IS OBTAINED BY: PERSONAL GROUND OBSERVATION AND EXPERIENCE | ESTIMATES BASED ON GENERAL WINDSHIELD SURVEY | TABULATION FROM A STATISTICALLY PLANNED FIELD SURVEY | TABULATION FROM AERIAL PHOTOGRAPHY | QUESTIONNAIRES FROM FARMERS | OTHER (please specify) |
|---|---|---|---|---|---|---|---|---|---|
| CROP TYPE | | | | | | | | | |
| CROP LOCATION | | | | | | | | | |
| CROP ACREAGE | | | | | | | | | |
| IRRIGATION TYPE | | | | | | | | | |
| IRRIGATION ACREAGE | | | | | | | | | |
| IRRIGATION LOCATION | | | | | | | | | |
| % IRRIGATION BY LOCATION | | | | | | | | | |
| PLANTING DATES | | | | | | | | | |
| HARVEST DATES | | | | | | | | | |
| HAY CUTTING DATES | | | | | | | | | |
| CROP SEQUENCE | | | | | | | | | |
| MINIMUM TILLAGE LOCATION | | | | | | | | | |

# APPENDIX V

# SAMPLE SOFTWARE OUTPUT

COUNTY ID #

| | 112 | 113 | 114 | 115 |
|---|---|---|---|---|
| COUNTY SIZE | | 0 | 0 | 0 |
| ROPPED AREA | 7130 | 5670 | 6410 | 6240 |
| RRIG AREA | 2500 | 34300 | 48000 | 9500 |
| WINTER WHEAT | 190000 | 229000 | 155000 | 106000 |
| PRING WHEAT | 0 | 0 | 0 | 0 |
| BARLEY | 1100 | 800 | 600 | 200 |
| ATS | 800 | 300 | 500 | 100 |
| RY BEANS | 0 | 0 | 0 | 0 |
| GAR BEETS | 0 | 0 | 0 | 0 |
| ORN | 500 | 13300 | 28100 | 100 |
| ALFALFA | -1 | -1 | -1 | -1 |
| YE | 4900 | 700 | 100 | 100 |
| POTATOES | 0 | 0 | 0 | 0 |
| ORGHUM | 13000 | 5100 | 21000 | 15000 |
| OYBEANS | 400 | 7500 | 200 | 300 |
| FLAXSEED | 0 | 0 | 0 | 0 |
| OTTON | 0 | 0 | 0 | 0 |
| IRRIG COTTON | 0 | 0 | 0 | 0 |
| RRIG SORGHUM | 0 | 0 | 0 | 0 |
| EANUTS | 0 | 0 | 0 | 0 |
| IRRIG PEANUTS | 0 | 0 | 0 | 0 |
| UNFLOWERS | 0 | 0 | 0 | 0 |
| MISC | 0 | 0 | 0 | 0 |
| ISC | 0 | 0 | 0 | 0 |
| RR WHEAT | 0 | 0 | 0 | 0 |
| PRP | 0 | 0 | 0 | 0 |

REAS ARE IN ACRES EXCEPT FOR COUNTY SIZE AND CROPPED AREA WHICH ARE IN HUNDREDS OF ACRES.
NTER "1" TO CONTINUE,"2" TO STOP.
?2

# APPENDIX VI

## STEPS IN PRELIMINARY 1980 CROP CALENDAR STUDY

Below is a listing of the minimum procedural steps necessary to determine the optimal Landsat dates for the High Plains Crop Calendar Project.

1) Make an overlay of the crop reporting districts (CRD) for the study area. (This has already been done.)

2) Read through the Crop and Livestock Reports and determine and code for each CRD:

   a) the crops grown

   b) the phenological data for ground preparation, planting, emergence, heading, yellowing, and harvest.

As the reports are gone through, these data will be recorded on the overylay of the study area.

EXAMPLE:

CRD 7

```
W  - gp 9/4,  p 9/15, e 9/30, he 4/30, y 5/30, ha 6/30
C  - gp 4/30, p 5/15, e 5/30, he 7/15, y 8/10, ha 9/1
S  - ......
SB - ......

                                                CRD - NE
```

where W = wheat, C = corn, S = sorghum, SB = soybeans; gp = ground preparation, p = planting, he = heading, y = yellowing, ha = harvest

3) The crops for each CRD are then compared phenologically to determine the best date of Landsat for crop separability and noted on the overlay.

4) An overlay of Landsat centerpoints is made.

5) The dates for Landsat imagery are then chosen corresponding to the date by CRD and Landsat centerpoint.